YEAR 2007

Annual Report

NOAA's NATIONAL CLIMATIC DATA CENTER

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Director's Message

In 2007, the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) fulfilled its core mission with excellence. I am pleased to report that NCDC again met or exceeded all its performance measures during the year.

In addition, the Center also strengthened its communication with users, its collaboration with national and international colleagues, and its capacity to provide data access through tools, systems, and management innovation. Taken together, these activities uniquely position NCDC to respond to the growing demand for timely and relevant climate services in an authoritative manner.

NCDC plays a central role in providing weather and climate data that serves broad social and economic interests. In 2007, NCDC hosted a conference on NOAA data and information that brought together energy, transportation, and insurance sector representatives and scientists, educators, and federal program managers. The conference sparked discussions on the growing value of NOAA data and information for economic decision-making in a non-stationary climate. Similar dialogues occurred between NCDC and the local Asheville community, the State Climatologists and Regional Climate Centers, the Climate Database Modernization Program, and through the NCDC Integrated Data and Environmental Applications Center partners in the Pacific.

The Center continued its robust contribution to advancing climate science in 2007. NCDC's participation in the U.S. Climate Change Science Program (CCSP) has led to increased confidence in our understanding of observed climatic changes and their causes. The U.S. Climate Reference Network topped 100 stations in the continental U.S. in 2007. Through its long-standing participation in the Intergovernmental Panel on Climate Change (IPCC), NCDC was honored to share in the IPCC's recognition through the 2007 Nobel Peace Prize. NCDC's suite of climate monitoring reports, including the *State of the Climate* reports, also remained a touchstone of information for a broad array of users.

Significant advances in data access were made in 2007. The NCDC-led NOAA Virtual Data System, NOMADS, and other Center systems served millions of users with over 300 terabytes of data. NCDC is happy to report that the Comprehensive Large Array-data Stewardship System facilities in Boulder and Asheville are now considered operational and over the course of the next year will be integrated into Center operations. Significant hardware upgrades were made in 2007 to handle the 1.5 petabytes of data available from NCDC's website.

NCDC led development of the U.S. Drought Portal (www.drought.gov) under the National Integrated Drought Information System. A number of critical tools were also developed to provide ready access to national mosaic precipitation and severe weather data. In 2007, the Global Observing Systems Information Center transitioned to a global data facility operated by NCDC.

From support of satellite programs like NPOESS to leadership as a World Data Center for Meteorology and Paleoclimatology, NCDC continues to be a highly respected national and international resource for climate information. I invite you to learn more about our activities and accomplishments described in this report.

Thomas R. Karl, L.H.D.
Director

What is a Program of Climate Services?

Throughout modern human history, individuals, communities, businesses, and governments have attempted to incorporate a basic understanding of seasonal climate conditions to help guide decisions in agriculture, water resource management, risk management, and other sectors. For much of this time, historical experience served as the primary guide for anticipating how conditions would change from season-to-season and year-to-year. During the past few decades, scientists and the public have recognized that certain climate system patterns—such as the El Niño-Southern Oscillation cycle in the Pacific Ocean—bring changes in rainfall, temperature, and storms that cause one year to differ from another when viewed in the historical context. As a consequence, scientists have now developed ways to forecast those key patterns of seasonal climate variability and governments, businesses, and communities around the world have begun to integrate those forecasts as part of their risk management decisions. More recently, through the activities of the Intergovernmental Panel on Climate Change (IPCC) and related efforts, scientists and public policy officials have recognized that we are entering a world in which our understanding of past and present climate patterns alone may no longer be a sufficient guide to understanding and managing the human partnership with the Earth's climate system. The climate of the future may be significantly different from that of the past. Understanding, anticipating, and responding to these changing climate conditions will be essential to our future well being. Providing a reliable and continuing source of information about changing climate conditions to manage risk and enhance the resilience of communities around the world is a goal of a climate services program.

An effective climate services program requires the following:

- A critical new partnership between the users of climate information in government, businesses, and communities and the providers of that information in government, academia, and the private sector. A collaborative program of shared learning and joint problem solving by these partners will help us understand the impacts of changing climate and the kinds of information necessary to develop effective options for mitigating and adapting to those impacts. These new insights can help guide both the development and application of new climate information products and the design of future programs of climate observations, science, and services.

- A new level of integration among the national and international communities of scientists who observe, study, model, predict, and assess the impacts of changing climate conditions and a renewed commitment to the management of the data that provides the essential foundation for those scientific efforts.

- A new approach to data management which focuses on the transformation of climate data into climate information and supports the delivery and application of that information in innovative new ways that help a variety of users in communities, governments, and businesses throughout the world answer critical questions and guide decision making.

We are already seeing the emergence of climate services activities with such developments as the use of forecasts of El Niño to strengthen programs and policies in agriculture, water resource management, disaster management, health, fisheries, and other key sectors. Analysis of past climate conditions are revealing trends and changing climate patterns that, in turn, can help guide community planning and economic development decisions. Continuously assessing the influence of human activities on the climate system can continue to inform policy decisions that support sustainable development at local, national, and international levels.

In the end, an effective climate services program will support the emergence of a new and mutually supportive partnership between society and the climate system that sustains us, helping us address today's problems while planning for the future.

Hub PROJECT

NCDC is partnering with public, educational, and private organizations in Asheville and Buncombe County, North

How Can We Respond to Changing Climate?

Effectively responding to changing climate conditions focuses on reducing the vulnerability of communities, businesses, and ecosystems. Understanding vulnerability requires an assessment of the following:

(1) how exposed am I to climate-related risks;
(2) how sensitive am I to those risks; and
(3) how well can I adapt to changing conditions (which is a measure of resilience).

Reducing vulnerability to climate change, then, can be achieved through a combination of efforts to reduce either exposure or sensitivity to risk–mitigation–and efforts to strengthen resilience through adaptation.

Carolina on the Asheville Hub Project (www.ashevillehub.com). The Hub Project is pursuing specific strategies for economic development, including attracting more federal government and private meteorological agencies and companies to Western North Carolina.

The Asheville Hub Project should give NCDC scientists a good way to collaborate with people who have expertise that complements the work done at NCDC providing benefits for NCDC and the local community. For example, scientists talk with city planners about urban planning challenges, and together, they learn to speak a more common language addressing how climate affects regionally specific issues. City planners can then extend this knowledge to their decisions.

2007 NOAA Data Users Conference

In November 2007, over 200 participants from the energy, transportation, and insurance sectors along with scientists, educators, and program managers from NOAA and other federal agencies convened at the Grove Park Inn in Asheville, North Carolina for NOAA *Data and Information for a Changing Climate: A Conference for Public and Private Sectors*. Through plenary presentations from industry and scientific leaders, panel presentations, and sector-specific working group discussions, participants explored the following:

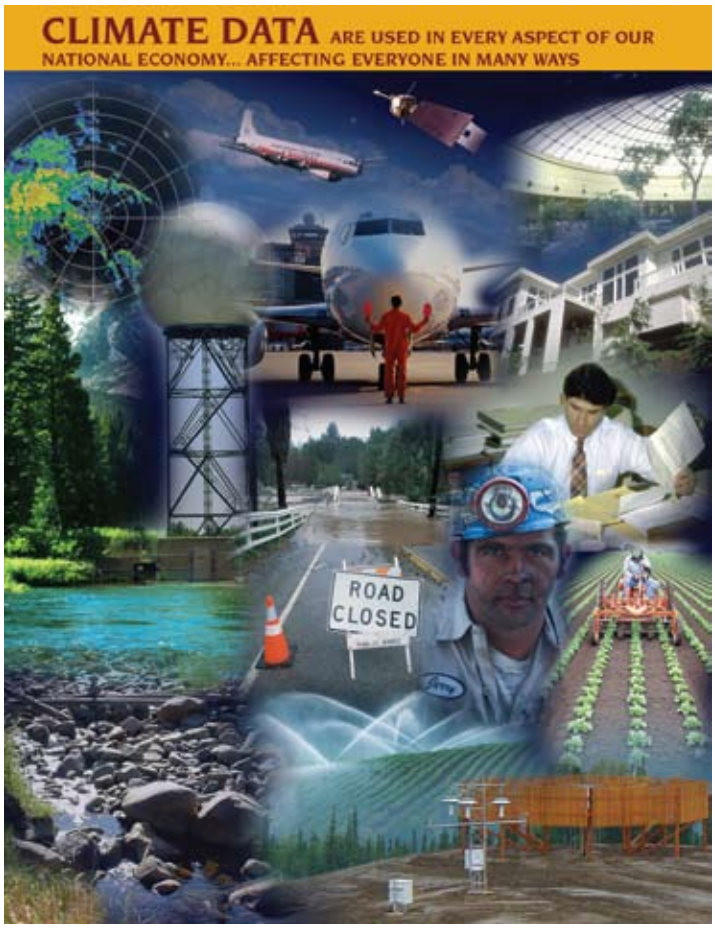
- Key challenges and/or information needs that changing climate conditions present for the energy, transportation, and insurance sectors;

- Critical information needs and gaps in current products and services;

- Strategies for meeting those needs as part of a climate information service for the future; and

- Guidance on how NOAA can continue the sectoral dialogue begun at the conference to better understand user needs and help guide future data products and services.

Sectoral working group chairs summarized their discussions during a closing plenary session and the conference concluded with an overview of some shared themes and next steps. NCDC staff and working group chairs are currently developing sector-specific scoping papers, which will summarize key findings and recommendations and provide general guidance for future activities. Conference proceedings and presentations can be found at the conference website (www.noaadata.com).



Regional Climate Centers (RCCs)

In 2007, NCDC's six RCCs continued to deliver excellent climate service, serving more than twenty million customer requests each month through the distributed data service called the Applied Climate Information System (ACIS). Bridging the gap between NCDC and the National Weather Service (NWS) climate services, the RCCs built the Web Xmitted Cooperative Observer Data Encoded Report (WxCoder III), a method to improve data observation collection. Also in 2007, the Southeast RCC changed locations, moving from Columbia, South Carolina to Chapel Hill, North Carolina.

Along with the State Climatologists, the RCCs brought regional and local expertise and assistance to a wide range of customers in all fields including building design, irrigation, pest management, energy, risk management, and natural hazards. Several states entered into new Memorandums of Understanding (MOU) agreements with NCDC and the American Association of State Climatologists, Inc. (AASC), which was newly incorporated as a non-profit corporation registered in Buncombe County, North Carolina, helping to secure Asheville as a center for climate services at national, regional, and state levels. Working together with NWS, RCC, and the State Climatologists, NCDC secured its role in user-centric tiered national climate services.

NCDC/University of North Carolina (UNC) Asheville Partnership

Collaborations in 2007 with the University, which has earned a national reputation for its programs in the humanities, undergraduate research, atmospheric sciences, and environmental studies, include:

- A project to produce *Planning for Climate Change*, A *Handbook for City, Town and Rural Area Planners* which was presented to the American Planning Association and at American Meteorological Society (AMS) meetings.

- Impressive results from the UNC Renaissance Computing Institute (RENCI) collaborative project on the Decision Theater for Visualization of Climate Scenarios for Policymakers and also the Storm Risk Assessment Projects (SRAP) led to outreach demonstrations.

- NCDC scientists lectures in Climate and Culture master level classes at UNC Asheville.

Asheville, NC Chapter of the American Meteorological Society (AMS) Named AMS *Chapter of the Year* for 2007

NCDC contributed significantly to the Asheville, North Carolina AMS Chapter earning recognition as AMS *Chapter of the Year* for 2007. Two NCDC employees served as chapter officers—David Urbanski as Vice President and Marjorie McGuirk as Membership Chairperson. In addition, NCDC scientists spoke at seven of the chapter's eight meetings during the year, including three of the chapter's *Climate Change Series* lectures. This first-ever lecture series hosted by the Asheville Chapter was well received, with an average attendance of nearly 200 at each of the three events.

In addition to being named AMS *Chapter of the Year,* the Asheville Chapter was recognized at the AMS National Conference with the award for *Chapter Poster of the Year* produced by NCDC Graphics.

NCDC Internship Program

This was the sixth year of NCDC's Internship Program. Students from across the Nation are invited to participate in the program which provides students with an opportunity to learn in a real work environment and gain hands-

on experience in their particular area of interest. Each student is required to prepare a presentation about their experience. The 2007 Intern names, academic affiliations, and presentations:

Jefri Cobb, University of North Carolina Asheville, *My Internship Journey*

Alex Bridygham, San José State University, *Repository Migration*

Alisa Young, Georgia Institute of Technology, *Calibration of the* ISCCP B1 *Water Vapor Channels Using* NOAA/HIRS 17 *Measurements*

Casey Niemiec, Valparaiso University, *The New* US *Climate Divisions*

Linda Wei, North Carolina School of Science and Mathematics, *Using Java to Support Climate Monitoring*

Quintin Ash, North Carolina Agricultural and Technical State University, CM *Change Request Form Exposition*

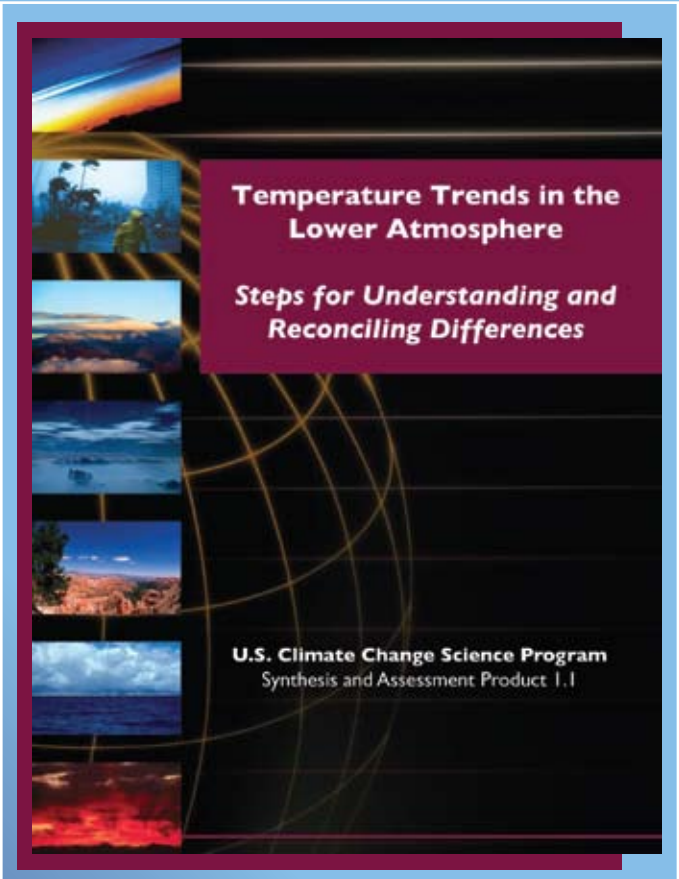
Megan Stone, University of North Carolina Asheville, *Global Observing Systems*

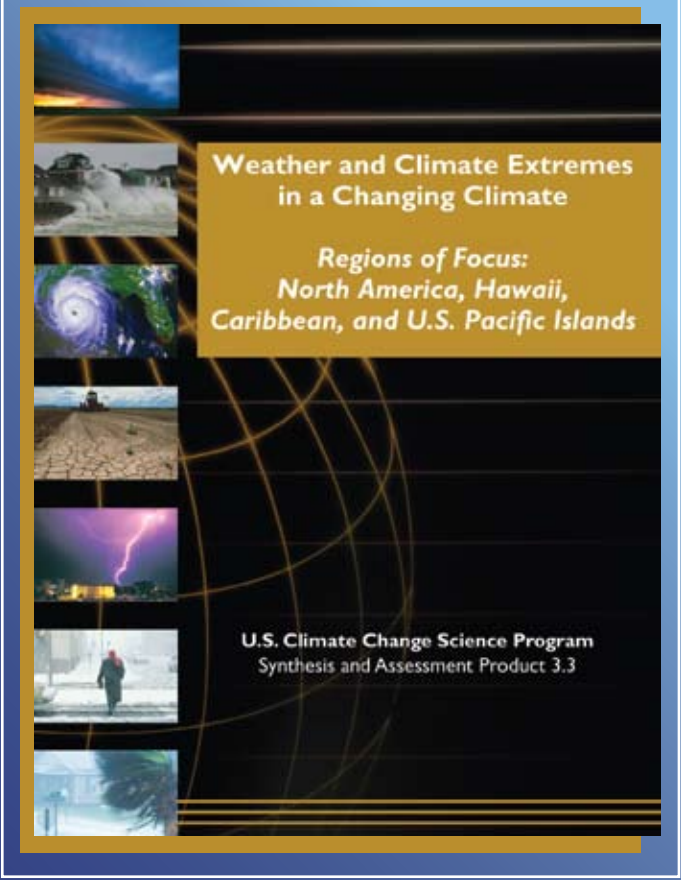
Joshua Wilcox, A.C. Reynolds High School, Asheville, North Carolina, *Upgrade to the* GIBBS *website*

Climate Change Science Reports and Assessments for the United States

NCDC is currently actively engaged in helping to write and produce a series of climate change reports on topics of critical importance to the United States. These reports, which were commissioned by the U.S. Climate Change Science Program (CCSP), reflect topics as diverse as weather and climate extremes, sea-level rise, and using climate forecasts in the water resources industry. Each of the assessments are aimed at informing both the science and non-science community, including the public, congress, media, and resource managers, about the state of our knowledge in key areas of climate change science. Engaging those who need to make decisions in the face of climate change is an essential component of producing these reports.

Two of the reports are led by NCDC authors, one was completed in 2006 (*Temperature Trends in the Lower Atmosphere*), and the other was in final review at the end of 2007 (*Weather and Climate Extremes in a Changing Climate*). In addition to the lead authorship of two reports, several NCDC scientists are authors on other reports, and a graphics and editing team is responsible for producing all NOAA-led reports, totaling nine in all. This effort includes ensuring that all material is accessible to non-scientists and preparing these reports to be distributed and used by all interested audiences including decision makers at the national, regional, and local level.





Update on the U.S. Climate Reference Network (USCRN)

In FY2007, the USCRN Program deployed 20 new stations for a total of 99 installed USCRN stations, 96 of which are commissioned. The network is 86 percent complete and the remaining 14 percent (16 stations) will be deployed in FY2008. NCDC has a performance measure to determine explained

variance for annual average temperature and precipitation in the contiguous United States, and in 2007, the USCRN improved the amount of explained variance to over 97 percent for temperature and over 94 percent for precipitation.

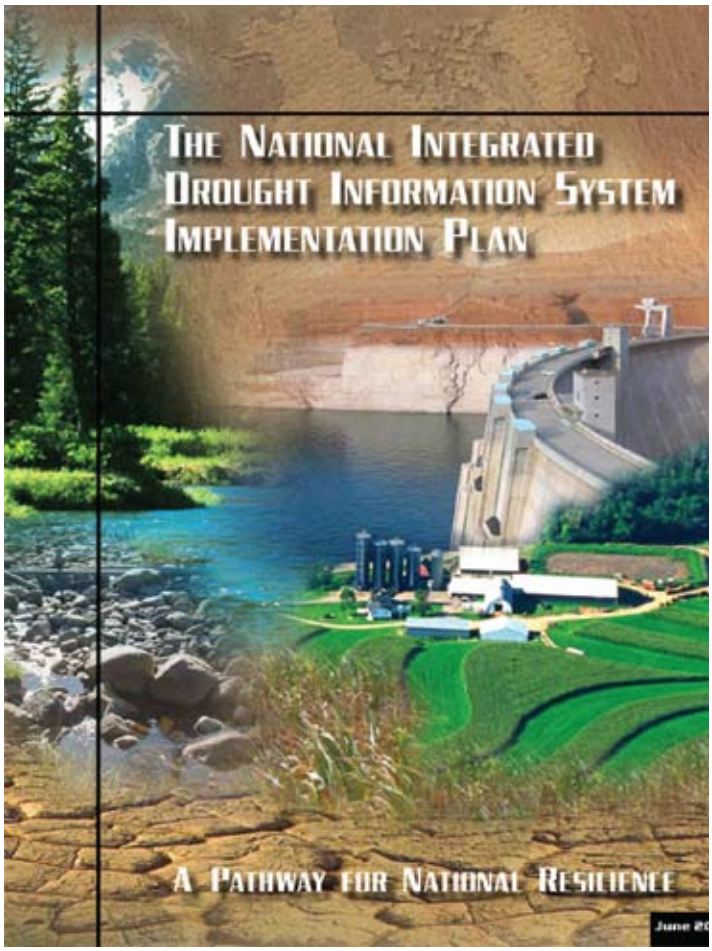
The testing of next-generation and supplemental sensors was continued, the temperature and precipitation calculation algorithms were refined and the backlog of station and instrument metadata queued for archive was significantly reduced. The remaining site surveys required for the FY2008 deployments were completed and reviewed in FY2007. Plans were made for the FY2008 transfer of the multi-year CRN precipitation experiment located at the NOAA/NWS Sterling Research and Development Center which will be impacted by Dulles International Airport's plans to expand a runway. The experiment considers the performance of precipitation measurement systems during snows with high winds.

The present-generation CRN precipitation gauge (Geonor) was selected in FY2007 as the control gauge for the new World Meteorological Organization (WMO) Precipitation Intensity Test Site in northern Italy. The selection was based upon the field performance and evolution of the CRN implementation of the gauge. The CRN station configuration has been selected by the Global Climate Observing System (GCOS) Program for deployment in various global environments where climate observation modernization assistance is requested. Two CRN stations were deployed to two extreme Hawaiian environments (Mauna Loa and Hilo) as prototypes for high-elevation and high precipitation environment GCOS stations.

An expanded description of the USCRN FY2007 Annual Report is available at: ftp://ftp.ncdc.noaa.gov/pub/data/uscrn/documentation/research/FY07_USCRN_Annual_Report.pdf.

Better Access to Drought Information

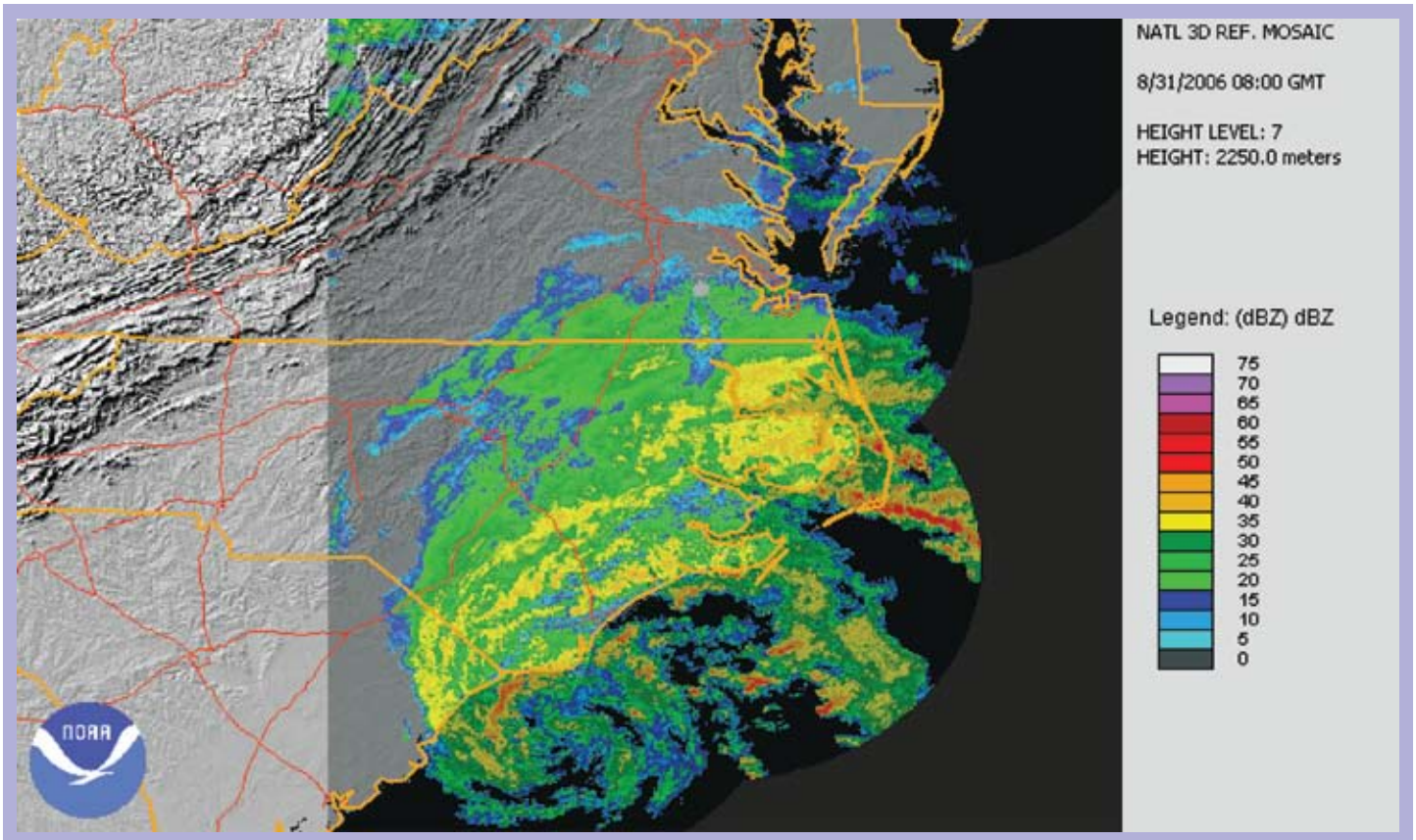
In November 2007, NOAA, along with other government agencies, unveiled a new website through which the public can monitor U.S. drought conditions and forecasts and obtain information about drought impacts in their communities and possible mitigation measures. Called the U.S. Drought Portal, www.drought.gov provides a weekly updated map on drought conditions. NCDC also continued to work with other U.S. Government agencies on the National Integrated Drought Information System (NIDIS). NIDIS is a drought risk information system that allows users to determine the potential impacts of drought and provides the decision-support tools necessary to better prepare for and mitigate



the effects of drought. Along with the existing international cooperation on a monthly data product called the North American Drought Monitor, these tools serve as an international model to help coordinate drought preparedness, response, mitigation, and recovery activities.

Reanalysis National Mosaic and Multi-Sensor Quantitative Project (NMQ)

NCDC is partnering with Cooperative Institute for Mesoscale Meteorological Studies (CIMMS) at the University of Oklahoma, RENCI, and NOAA/National Severe Storms Lab (NSSL) on an NMQ quantitative precipitation estimation (QPE) reanalysis. The project takes advantage of the Weather Surveillance Doppler Radar (Level II) historical data from NCDC archives, RENCI computing power, and NSSL's methodologies to generate 3-D radar reflectivity and 2-D products such as composite reflectivity, Echo Tops, and QPE products. However, these products are not based on operational time scales; they support climate services by deriving climatologies such as a 1km gridded 10-year precipitation climatology. NCDC will leverage RENCI's 1 Petabyte of computing disk space to do a reanalysis and build



NMQ of Ernesto with relief map background

products for storm climatology studies and drought that will be made available in NCDC's Storm Data/Severe Weather Data Inventories (SWDI).

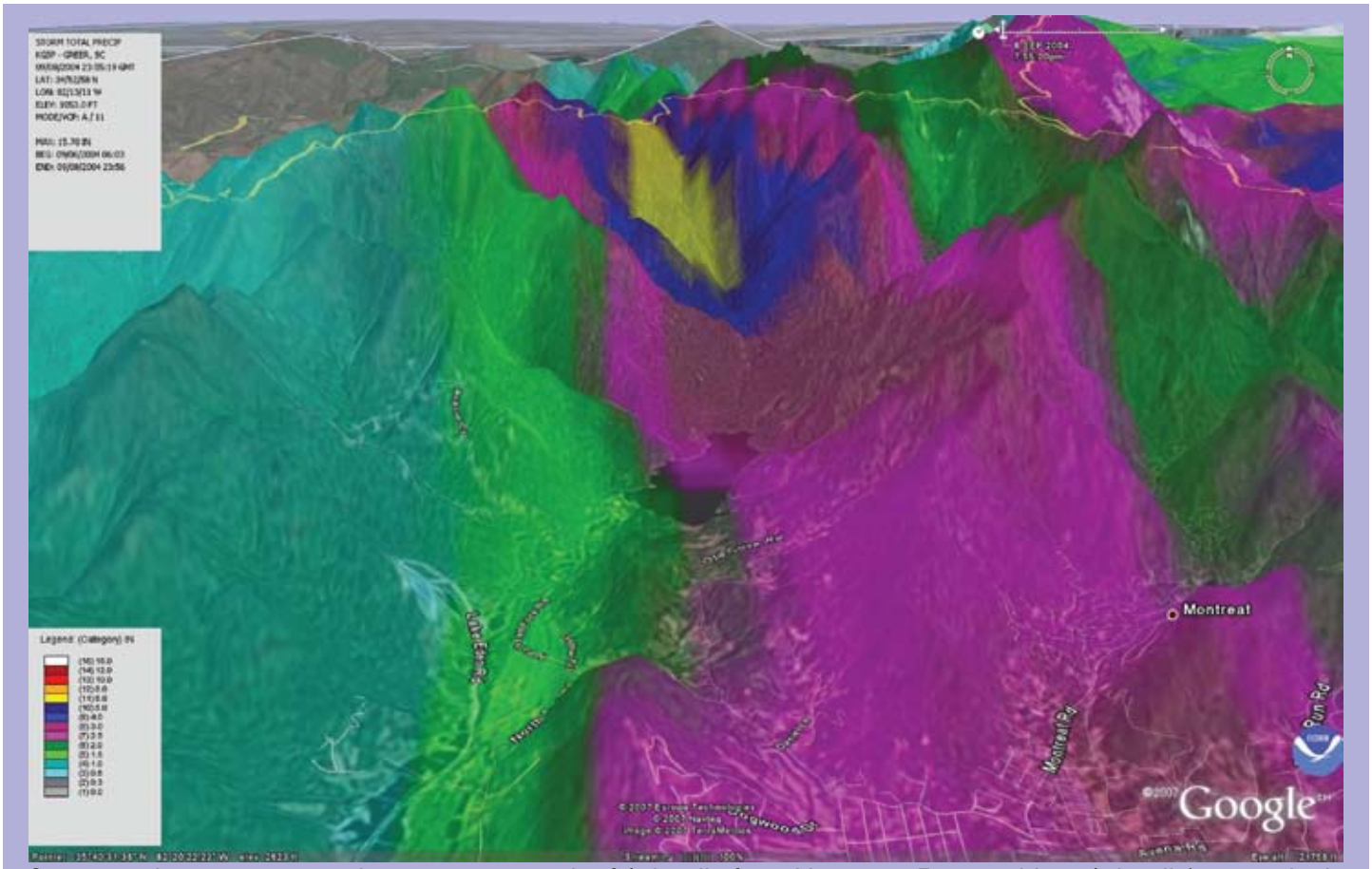
Storm Risk Assessment Project and (SRAP) and Severe Weather Data Inventory (SWDI)

NCDC is partnering with the National Environmental Modeling and Analysis Center (NEMAC) at orgs.unca.edu/nemac/ and RENCI at www.renci.org/on SRAP and SWDI to derive severe weather data products (e.g., climatologies). This includes trend analysis and risk assessment of storms, including hurricanes, tornadoes, drought, floods, lightning, hail, and storm reports with damage and the utilities to map these analyses and assessments spatially against social databases to assess populations at risk. Access systems take advantage of data decoders, geo-spatial databases, and data servers to provide a user-friendly and efficient manner in which to obtain the needed data. Derived products based on retrospective data (NCDC Archives), such as flash flood climatology and other NCDC SRAP products, are stored so that they are directly accessible and applicable to the RENCI UNC engagement site for North Carolina planning needs and for planning local government emergency response.

The tools will be developed so that new data sets can be added, and the data will be served in ways that will allow for various client side applications such as Geographic Information Systems (GIS), and other web-based querying applications. While phase one of SRAP is based on deriving products from retrospective data, expansion of the project includes real-time data, allowing visualization of storm risk assessment with current weather conditions. Ultimately, products will include: 1) Modular, Service Oriented Architecture (SOA) design of SWDI and SWDI access, 2) Storm Risk Assessment dynamic web page and online analysis tools, 3) Web Service based (GIS, Simple Object Access Protocol [SOAP], and Representational State Transfer [REST]) access to SWDI and Storm Risk data, and 4) GIS data and visualization layer of SWDI-based risk assessments.

The Global Observing Systems Information Center (GOSIC)

The GOSIC at gosic.org serves as a central data integration facility for the data and information requirements related to global observing data access and retrieval. The GOSIC began as a developmental activity at the University of Delaware in 1997, and as of January 2007, has fully transitioned to an operational global data facility operated by NCDC on



Storm total precipitation in the mountains north of Asheville from Hurricane Frances. Note Asheville's watershed in the center of the picture.

behalf of, and with the concurrence of, the global observing community. The GOSIC provides information and associated tools to facilitate better access to data and information produced by the Global Climate, Ocean, and Terrestrial Observing Systems and their partner programs.

Such a single entry point for users best serves the distributed nature of this vast system of global and regional data and information systems. GOSIC provides that entry point by performing the following functions: providing global data system documentation and metadata, providing an integrated overview of the various global observing programs, and facilitating online access to their data, information, and related data services. GOSIC offers a search capability across international data centers in order to better facilitate access to a worldwide set of observations and derived products that provide the end user with a consistent interface across all centers.

In addition to supporting the global observing community's data and information needs, it also supports the data management operations of the World Data Center (WDC) for Meteorology, Asheville. Furthermore, the GOSIC assists NCDC's internal data management work by providing a focus for improving key data management facilities within NCDC, which all contribute to various aspects of the Global Earth Observation System of Systems (GEOSS). The Group on Earth Observations (GEO) Secretariat, recognizing the value of GOSIC's suite of data integration and retrieval tools, has invited it to participate in the scenario development and build-out of the GEOSS Architecture Implementation Pilot; additionally, GOSIC will also be working with the U.S. Global Earth Observation-Integrated Data Environment (GEO-IDE) Program Manager to assist that effort in providing data integration and retrieval assistance. An example involving climate data access is that via GOSIC's efforts, NCDC's data can now be viewed in the GeoNetwork at www.fao.org/geonetwork/srv/en/main.home and this is a direct result of GOSIC's proactive and flexible data integration efforts.

NCDC Scientists Contribute to the Intergovernmental Panel on Climate Change Nobel Peace Prize Process

Sixteen NCDC scientists, including current and retired staff, contributed to the IPCC, serving as authors, editors, and contributors for IPCC reports over the past several years. On

NCDC Scientists honored with a proclamation from the City of Asheville, North Carolina for their participation in the IPCC process that was awarded the 2007 Nobel Peace Prize. Pictured here: (left to right) Tim Owen, Dave Wuertz, Byron Gleason, David Easterling, Robert Eskridge (retired), John Bates, Pasha Groisman, Robert Quayle (retired), Thomas Peterson, Michael Crowe (retired), Richard Reynolds, Jay Lawrimore, Leonard Bernstein (non-NOAA participant). Participants not pictured: Thomas Karl, David Levinson, and Russell Vose (see NOAA NCDC Personnel Management and Staff sections, this document) and Richard Knight (retired).

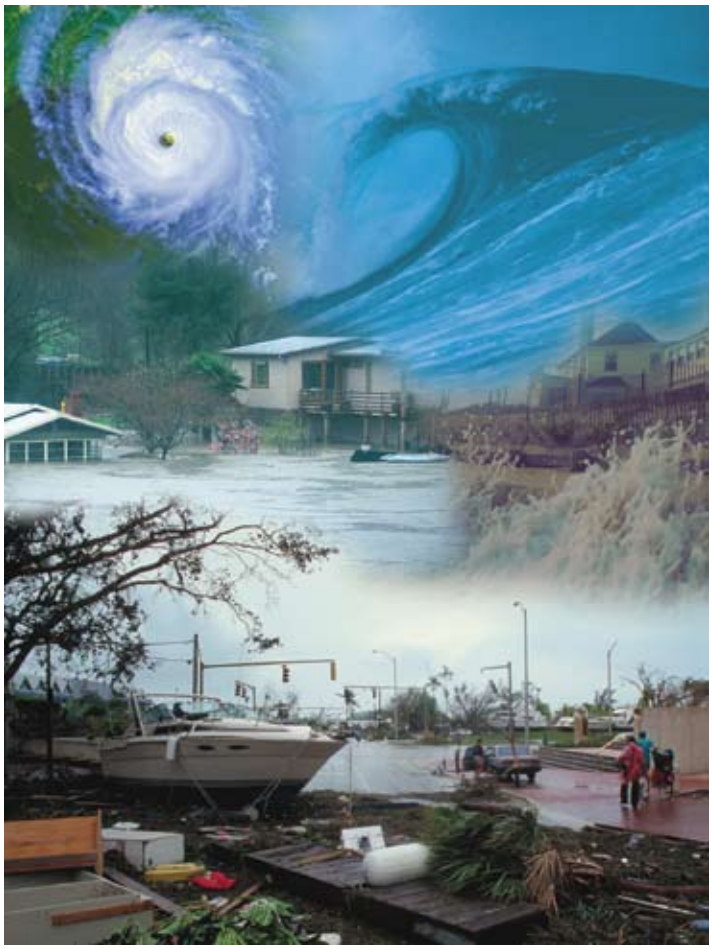
October 12, 2007, the IPCC was awarded the Nobel Peace Prize along with former Vice President Al Gore, "for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change." These scientists contributed key information that led to this very prestigious award. This international recognition highlights how important oceanic and atmospheric research and climate data are to the global community and how critical NOAA's work is to this effort.

Pacific Region Integrated Climatology Information Products (PRICIP) Project

Coastal storms pose a threat to the lives and livelihoods of the peoples of the Pacific. The PRICIP project arose out of a need to reduce the vulnerability of coastal communities to the economic, social, and environmental risks associated with coastal storms. Through the PRICIP project, the NOAA NCDC Integrated Data and Environmental Applications (IDEA) Center is working to address this need by improving our understanding of patterns and trends of storm frequency and intensity—storminess—within the Pacific region and by developing a suite of integrated data and information products.

The PRICIP portal is a gateway for data and information about coastal storms, and the strong winds, heavy rains, and high seas that accompany them. It represents the mechanism whereby data and information products developed through the PRICIP project, as well as those that originate from other sources, can be viewed and retrieved. Emergency managers, mitigation planners, government agencies, and decision-makers in key sectors including water and natural resource management, agriculture and fisheries, transportation and communication, and recreation and tourism all represent potential users of the portal. The intent is that easy access to up-to-date information about coastal storms will enable improved decision making.

As part of the initial build-out, the PRICIP portal is serving a set of historical storm event anatomies as a targeted information product proof-of-concept via a portal test bed. These event anatomies include a summary of sector-specific socioeconomic impacts associated with a particular extreme event (e.g., Hurricane Iniki, Typhoon Chata'an, Super Typhoon Pongsons, and Cyclone Heta) as well as its historic context climatologically. The intent is to convey the impacts associated with extreme events and the causes of them in a way that enable users to easily understand them. The event anatomies are also intended to familiarize users with in situ



and remotely-sensed products typically employed to track and forecast weather and climate.

Combining text and graphics as well as annotated or animated visualizations, the event anatomies are web-enabled using a standards-based, vendor-neutral, and open source enterprise portal and portlet architecture. By design, this approach provides personalization, single sign-on, and content aggregation from different sources while also being a web server for the presentation layer of the information systems. A portal could, therefore, feature sophisticated personalization features to provide customized content to users whereby portal home pages may have different sets of portlets that render content that is most relevant to a user.

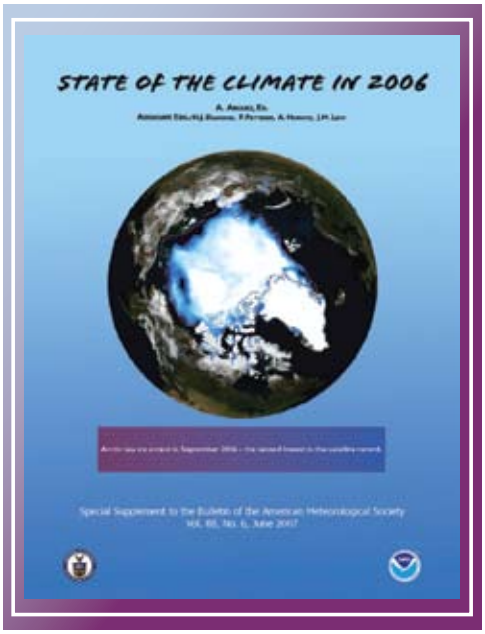
A suite of strong winds, heavy rains, and high seas derived data and product sets is part of the initial PRICIP. A simple query utility generates a Google map that displays a user-defined set of interactive station/system icons. Selecting a particular icon reveals basic information about the station/system and provides a list of links to specific PRICIP products and accompanying data sets (e.g., annual rates of change; annual, seasonal, and monthly event magnitudes; and event recurrence intervals of strong winds, heavy rains, and high seas). It also provides a link with instructions on how to obtain data/product metadata.

The PRICIP products and data sets accessible via this utility represent the results of analyses by the PRICIP theme-specific data integration and product development teams of NOAA's Integrated Surface Hourly (ISH) mean sea-level pressure and wind-speed data; the Global Historical Climate Network (GHCN) precipitation data set; the National Water Level Observing Network tide gauge records; the National Data Buoy Center wave buoy records; the U.S. Army Corps of Engineers' Coastal Data Information buoy data; and other data.

To view PRICIP proof-of-concept data and information via the portal test bed, go to www.pricip.org/.

2006 Annual State of the Climate

Publication of the 2006 Annual State of the Climate report in the June 2007 issue of the Bulletin of the American Meteorological Society continued NCDC's tradition of providing global perspectives on the Earth's changing climate. The scope of this annual report was expanded in 2007 with the addition of dozens of scientists contributing new analyses from around the world. The number of contributing authors grew to more than 150 from approximately 100 the preceding year.



These scientists, who represented 33 countries, turned raw observations, collected from the global array of observing systems, into information that enhanced the ability of decision makers to understand the state of the Earth's climate and its variation and change during the past year. The diverse set of topics in the report included information on 19 Essential Climate Variables such as surface and upper air temperature, precipitation, atmospheric trace gases, ocean salinity, circulation, and ocean carbon content, snow cover, sea ice, and sea level.

This report is part of an operational effort to monitor the Earth's climate on an ongoing basis and is complimented by monthly web-based State of the Climate reports and special reports provided in response to unusual climatic events. One of the most notable events in the United States was a record April cold outbreak that caused an estimated $2 billion in losses to agricultural and horticultural crops. Damages were exacerbated by early spring growth that occurred during an unusually warm March in which more than 3000 new daily high temperature records were established. NCDC scientists worked with experts from the NWS, RCCs, and the U.S. Department of Agriculture (USDA) to produce a NOAA technical report on the meteorological conditions, climate perspective, impacts, and services.

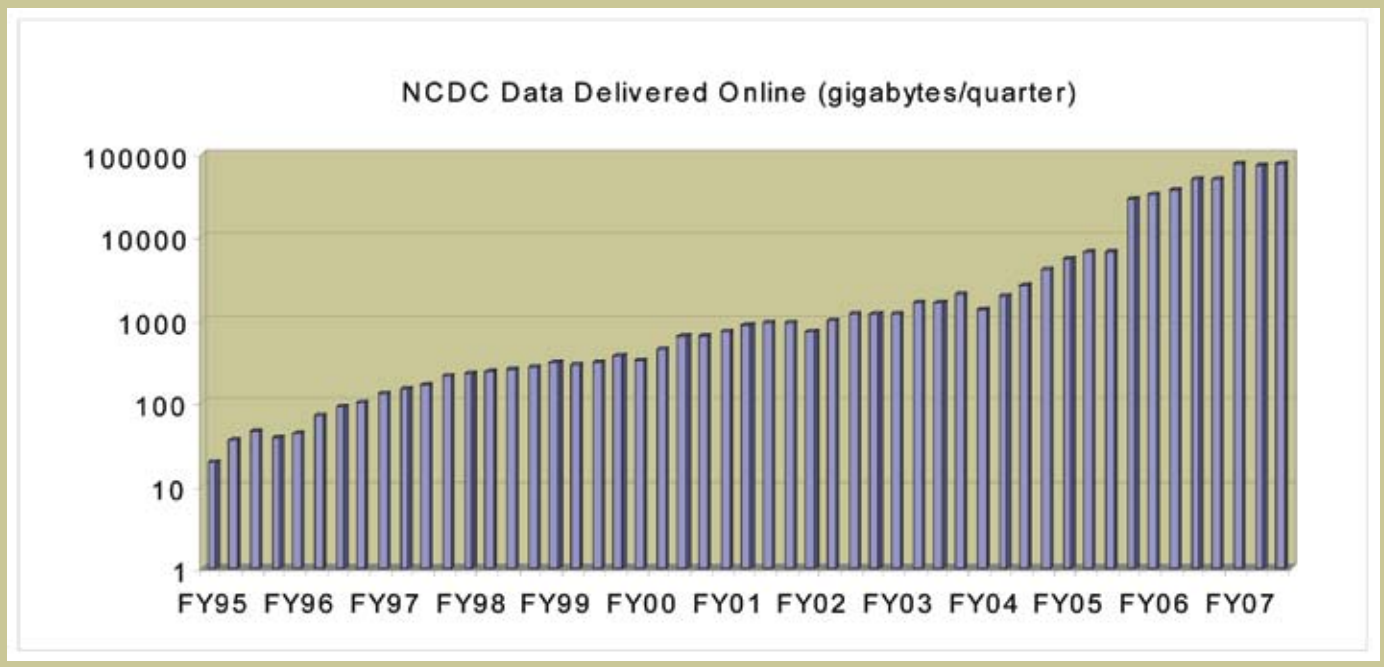
FY2007 Records Set for Data Access, NOAA Virtual Data System (NVDS)

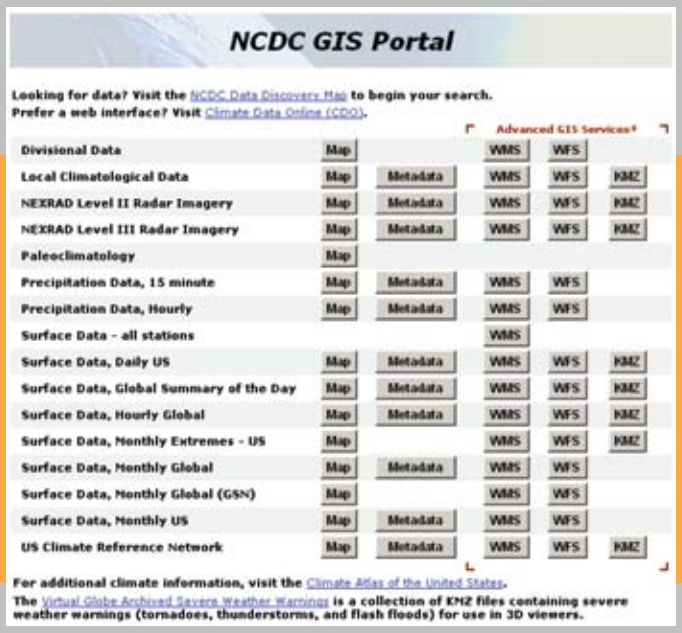
In FY2007, NCDC delivered over 300 Terabytes of online climate data, an 84 percent increase over FY 2006. This increase is due in part to the rapid growth in the in situ, Next Generation Weather Radar (NEXRAD), satellite, and model data; 1.5 petabytes of data are now accessible from NCDC's website. Because of the rapidly increasing system load, NCDC focused on implementing hardware upgrades to manage the growing demand.

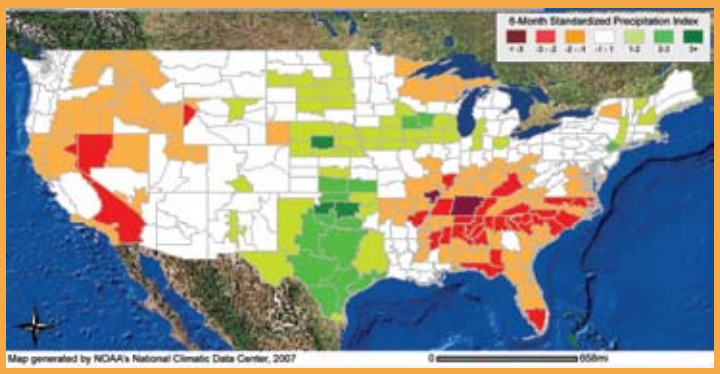
New software and online services included: 1) numerous GIS Services enhancements and additions; 2) a new National Solar Radiation Database (NSRDB), developed jointly with the National Renewable Energy Laboratory (NREL); and 3) surface data "climograms" (colorized graphical displays showing frequency distributions of various parameters), developed jointly with the U.S. Navy.

Products and services used to assist in drought monitoring and visualization (in collaboration with NIDIS) are illustrated on page 11, along with a sample "climogram" for Hilo, Hawaii–a new product with a colorized display showing frequency distributions of various parameters, developed jointly with the U.S. Navy in Asheville's Federal Climate Complex.

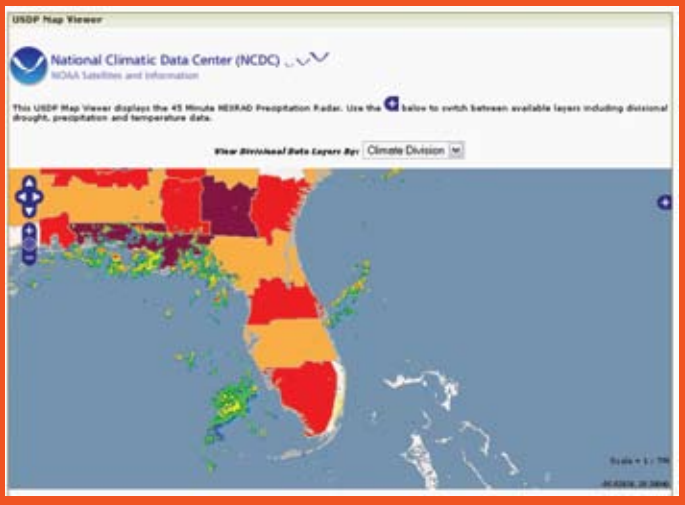
"Open access services" continue to grow in popularity and usage. Open access is generally defined as data access not requiring use of a web browser or specific graphical user interface (GUI), where users can obtain data via automated methods such as File Transfer Protocol (FTP) scripts, Web Services (e.g., SOAP, REST), or the Open-source Project for a Network Data Access Protocol (OpenDAP). Some of the "open

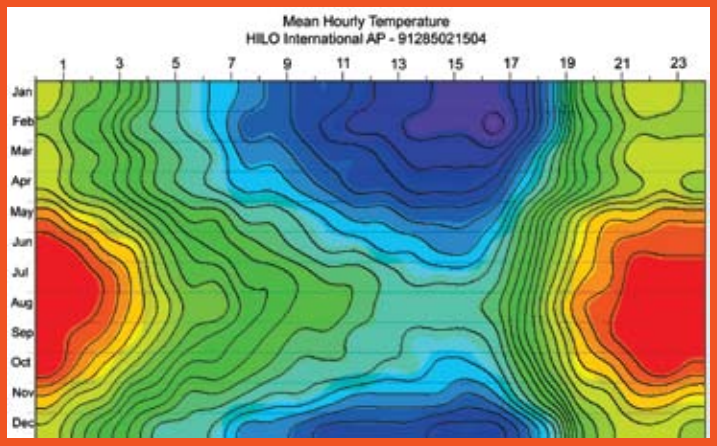






GIS Services URL: gis.ncdc.noaa.gov





acess" capabilities for NVDS data sets/products include:

1) FTP services for many data sets, including Integrated Surface Data (ISD, over 3 million files/month downloaded).

2) Web Services (for "Climate Data Online) are now in prototype mode in collaboration with the Consortium of Universities for the Advancement of Hydrologic Science and other partners.

3) Google-Earth and Open Geospatial Consortium (OGC)-compliant Web Map Services and Web Feature Services continue to be implemented.

Restoration of National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Climate Capabilities: Climate Data Records (CDRs)

The Office of Science and Technology Policy (OSTP) asked NOAA and the National Aeronautics and Space Administration (NASA) to assess the impacts of the NPOESS Nunn-McCurdy certification on joint agency climate goals. One of NOAA's goals is to understand "climate variability and change to enhance society's ability to plan and respond." Quality global satellite observations that provide climate information records over time are required to meet this goal. The sensors providing these observations and the related science processing were eliminated as part of the Nunn-McCurdy certification. It was critical that these global climate observations be continued.

The NOAA/NASA team provided leadership in developing a report critical to funding approval for the continuation of satellite-based climate records for understanding climate change. The report included the first systematic priority ranking of multiple climate space-based observations. This ranking was essential in establishing the benefit of polar-orbiting satellites.

NCDC continues participation in a joint NOAA, NASA, and U.S. Geological Survey (USGS) program plan to develop CDRs. The proposed program systematically evolves a candidate algorithm through a six-level research and operational path to maturity (illustrated in the figure below), and includes ongoing algorithm maintenance and technology insertion. The proposed program is jointly managed by the responsible agencies, but its execution relies extensively on community expertise and resources. The CDRs resulting from this program would provide a comprehensive set of climate data and information records (CIRs) useful for spatio-temporal detection, analysis, and prediction of environmental change, and for development of a complete and coherent environment for climate model execution.

NOAA National Operational Model Archive and Distribution System (NOMADS)

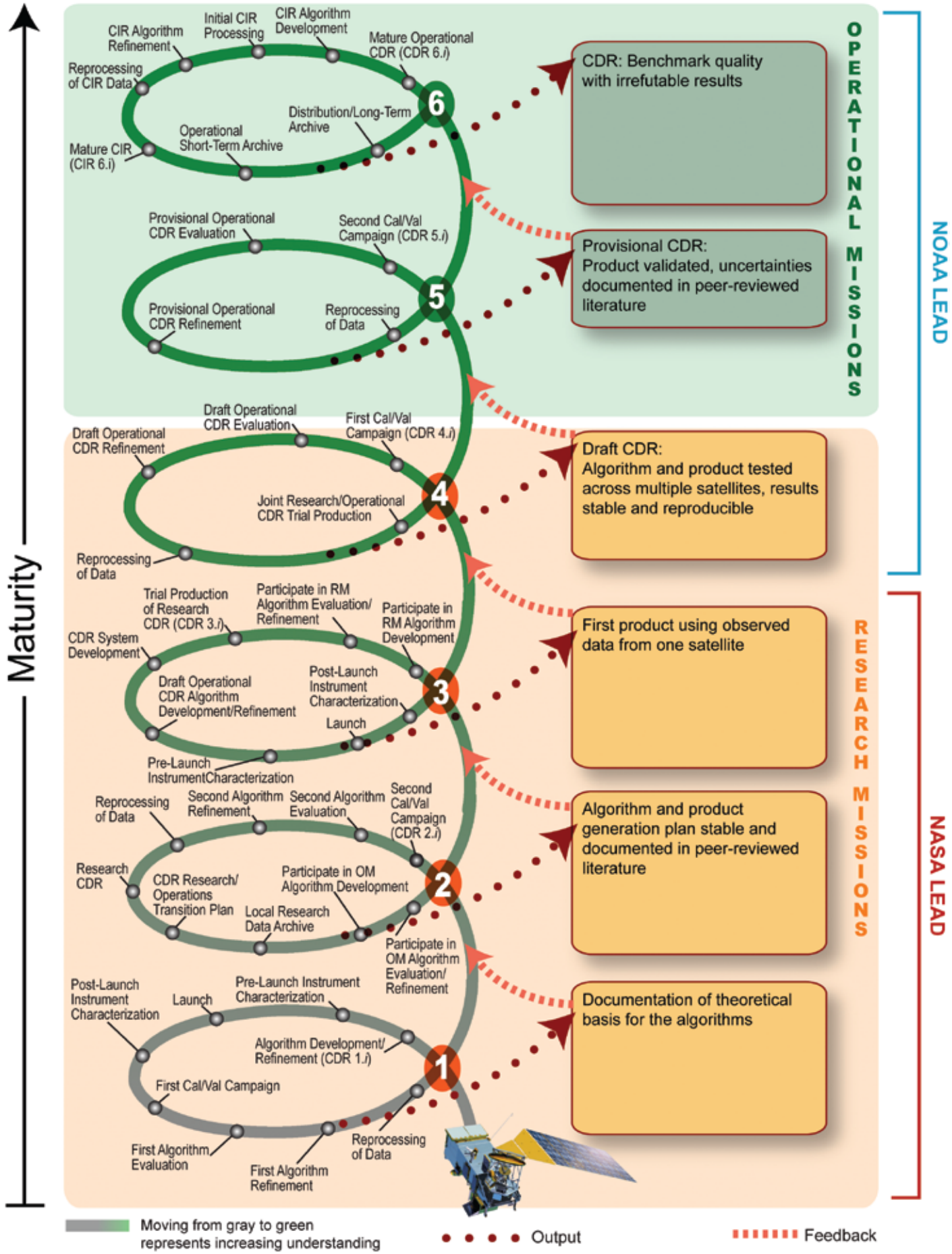
During 2007, the NOAA NOMADs at NCDC provided approximately 93 terabytes of near real-time and historical model data from 50 million user downloads. Under a new collaboration, NWS Headquarters, NCDC, the National Centers for Environmental Prediction (NCEP), and several university partners are jointly developing new operational requirements for the NOMADS for use within NWS operations. This will include a more robust ingest and quality control process, increased NOMADS usage within the NWS, and additional data sets including the Regional and Global Ensemble product suite. NOMADS is laying the framework to address the 2006 report from the National Academies National Research Council, Board of Atmospheric Science and Climate which concluded:

"NOMADS should be maintained and extended to include (a) long-term archives of global and regional ensemble forecasting systems at their native resolution, and (b) re-forecast data sets to facilitate post-processing."

Also during 2007, NOMADS participated in Phase-1 of The Observing System Research and Predictability Experiment (THORPEX) Interactive Grand Global Ensemble (TIGGE) project. This WMO project is an international effort to accelerate improvements in the accuracy of one-day to two-week high impact weather forecasts through the use of ensemble prediction. As part of this effort, NOMADS developed software needed to generate 11 new derived variables and transmit them to the Global TIGGE Archive at the National Center for Atmospheric Research (NCAR).

NOMADS provides standards-based access to other data forms not just model data, including a successful research-to-operations effort to include web services access to the Smith-Reynolds Optimum Interpolation Sea Surface Temperature and Blended Sea Surface Winds data sets, derived from multiple satellites and in situ observations that are part of a Pacific Region Integrated Data Enterprise (PRIDE) project between NCDC and the National Marine Fisheries Service (NMFS)/Southwest Fisheries Science Center.

CDR Evolution

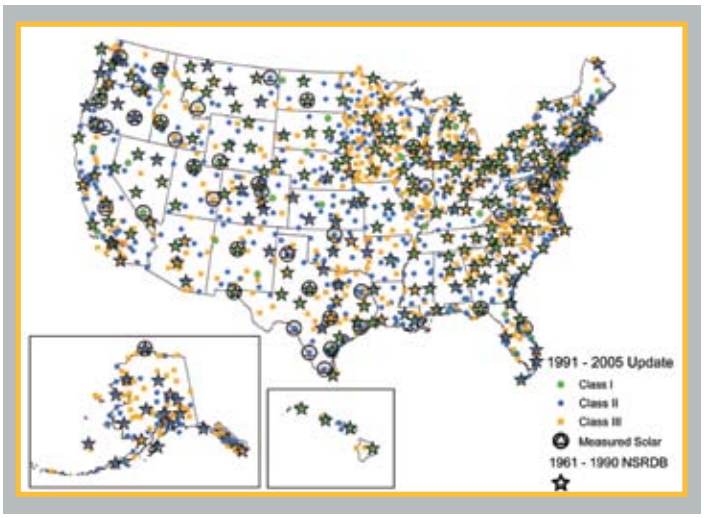


NCDC and NCEP are using NOMADS as the focus of providing archive and access to the upcoming NCEP Climate Forecast System Reanalysis and Reforecast (CFSRR). For more information on the NOMADS project, please visit: nomads.ncdc.noaa.gov/.

Archives and Models of Past Abrupt Climate Changes

NCDC's Paleoclimatology Branch, which operates the World Data Center for Paleoclimatology, archived a new collection of ice core records documenting past abrupt climate changes. These records, from sites in Antarctica and Greenland, have an unprecedented combination of long duration (spanning up to the last 800,000 years), high temporal resolution (up to decadal), and increasingly precise chronologies. Conclusions based on these records relate to two possible aspects of abrupt climate change in the future: the sensitivity of temperature to changes in atmospheric carbon dioxide and variations in the Atlantic Meridional Overturning Circulation (AMOC) caused by melting of the Greenland ice sheet.

On a similar theme, research activities in the Paleoclimatology Branch have included modeling the effects of past ice sheet melting on the AMOC during both glacial and interglacial times. The goal of this research is to identify the feedbacks that affect the duration and magnitude of ocean circulation changes, as well as the causes of regional climate impacts. By comparing model output with paleoclimate records such as those described above, it is also possible to evaluate the ability of models to simulate abrupt climate changes.



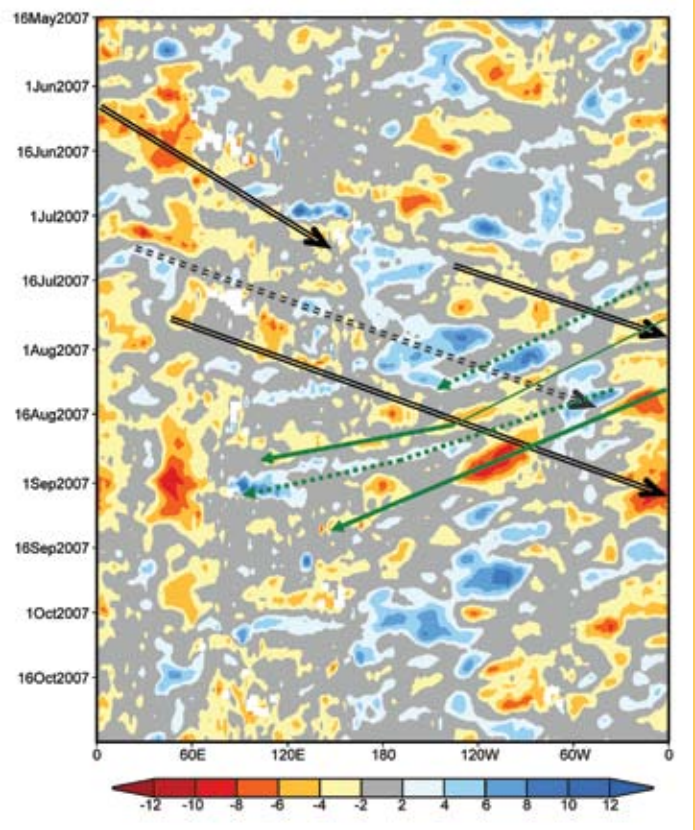
National Solar Radiation Database (NSRDB)

The success of any solar energy installation depends largely on the site's solar resource. Therefore, detailed knowledge of an area's solar resource is critical to installation planning and siting. To assist with these efforts, the National Renewable Energy Laboratory (NREL) and NCDC created a new NSRDB. The 1991–2005 NSRDB contains hourly solar radiation (including global, direct, and diffuse) and meteorological data for 1454 stations. This database builds on the 1961–1990 NSRDB, which contains data for 239 stations.

Since 1992, the data have provided solar planners and designers, building architects and engineers, renewable energy analysts, and countless others with extensive solar radiation information. The update includes the conventional time series for NSRDB ground stations as well as a one-tenth-degree gridded data set that contains hourly solar records for 8 years (1998–2005) for the United States (except Alaska above 60° latitude) for about 100,000 pixel locations (at a nominal 10-km-by-10-km pixel size). NSRDB is available online: ftp://ftp.ncdc.noaa.gov/pub/data/nsrdb-solar.

Upper Tropospheric Water Vapor (UTWV) Data Set for Tracking Tropical Waves

A global UTWV data set has been developed based on the High-resolution Infrared Radiation Sounder (HIRS) observations from the NOAA polar orbiting satellites. The data set has a spatial grid resolution of 2.5° and temporal resolution of one day, covering 28 years of measurement from 1979 to 2007. Intersatellite biases were removed by calibrating the data to a base satellite to create a temporal homogeneous record.



Time-longitude section of clear-sky UTWV anomaly averaged from 7.5S to 7.5N. Shaded colors are the 3-day running mean anomalies calculated by subtracting the daily climatological mean based on the 1979 to 2007 period. As an example, the black arrows indicate the propagation of several eastward moving Madden-Julian oscillations, and the green arrows show the westward propagating tropical waves which are most significantly over the western hemisphere (eastern Pacific Ocean, Central America, and Atlantic Ocean).

To track and monitor tropical waves, time-longitude sections of UTWV data near the equator are examined. Analysis shows that UTWV data have the advantage of around-the-globe coverage of equatorial waves compared to the outgoing longwave radiation data that are currently used by numerical prediction centers. Outgoing longwave radiation analysis typically only captures the tropical waves over the eastern hemisphere. The UTWV provides a continuous observation across both eastern and western hemispheres. UTWV data have been presented as part of the satellite observation contribution to the Year of Tropical Convection, which is a joint research activity of the World Climate Research Project, World Weather Research Program, and The Observing System Research and Predictability Experiment. The global satellite observation plays an important role in better modeling and understanding of tropical convection and its role in weather-climate connections from intraseasonal to interannual time scales.

Radar Data Visualization and Interoperability Tools

NCDC has developed radar visualization and data exporter tools in an open system environment. The NCDC *Interactive Radar Viewer and Data Exporter* will load Weather Surveillance Radar 1988 Doppler (WSR-88D) volume scan (S-band) data, known as Level-II, and derived products, known as Level-III, into an OPEN GIS-compliant environment. The application is launched via Java Web Start and runs on the client machine while accessing these data remotely from the NCDC archive or in near real-time from other NOAA servers. The Radar Interactive Viewer provides tools for custom data overlays, animations, and basic queries. The export of images and movies is provided in multiple formats that support the "blending" of radar data with other types of data.

The Data Exporter allows for data export in both vector polygon (Shapefile, Well-Known Text) and raster (GeoTIFF, ESRI Grid, VTK, NetCDF, GrADS) formats. NCDC recently partnered with NOAA's NSSL to decode Sigmet C-band Doppler radar data providing the NCDC Viewer/Data Exporter the functionality to read C-Band. This also supports a bilateral agreement between the United States and Canada for data sharing and to support interoperability with the US WSR-88D and Environment Canada radar networks. In addition, NCDC is developing decoders to read a test bed of distributed X- band radars that are funded through the Collaborative Adaptive Sensing of the Atmosphere (CASA) project.

By acquiring the capability of reading various radar volume scan formats (S-band, C-band and X-band) and exporting these data into common data formats such as Shapefile for GIS, the NCDC Radar Viewer and Data Exporter is compliant with the OGC and a common data model environment, these tools support programs such as GEO-IDE and GEOSS.

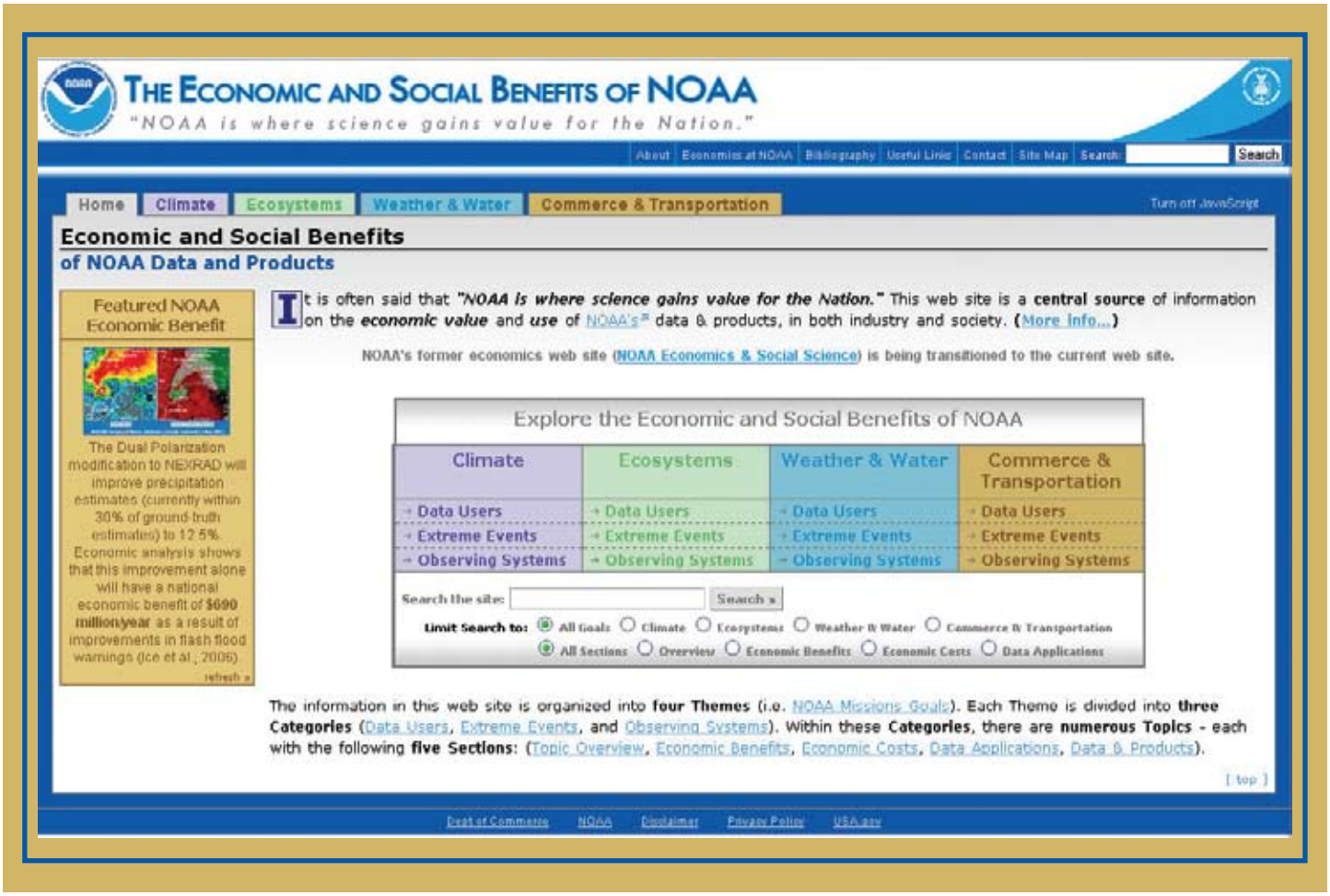
The Envirocast® Vikion™ TouchTable TT45 is an innovative tool for visualization, navigation, and analysis of data of NCDC data sets. Functioning as a mobile presentation and input device, the TT45 displays data on a touch-sensitive table surface. The TouchTable directly interfaces with Google Earth and ArcGIS, providing easy integration of existing NCDC data using GIS technology. Immediate capabilities include the visualization of Observation, Model, Satellite, and Radar data sets along with products such as the Drought Monitor. Additional TouchTables can be networked to allow synchronized remote collaboration with other NOAA offices allowing different groups to connect to the network and share data over long distances. Each device on the network displays the same information and is updated concurrently.

Web-Based International Multiproxy Paleofire Database (IMPD) Decision Support Tool

Fire is an important process in terrestrial ecosystems, with broader impacts on the landscape, and influencing not just human safety but diverse economic sectors. In 2007, NCDC's Paleoclimatology Branch, in collaboration with fire history and paleoclimate scientists, expanded the IMPD. The IMPD is an online database of fire history derived from paleoenvironmental proxies such as tree-ring fire scars and charcoal in lake sediments. This growing body of fire history data provides opportunities for investigating the role of fire in ecosystems and the feedbacks that link fire, climate, vegetation, and management decisions.

Fire regimes (or fire personality types) across the United States are changing. Land managers need to prioritize wildland fire mitigation by considering how fire regimes have changed through time. To accomplish this, a new web-based decision support tool will improve access to the IMPD for resource managers in their planning and decision making with respect to wildland fire. Collaborating partners in this effort include NOAA/NCDC, The University of Arizona, Rocky Mountain Research, Inc., and U.S. Forest Service (USFS) Rocky Mountain Research Station.

For more information about the IMPD visit: www.ncdc.noaa.gov/paleo/impd/.



NOAA Socioeconomic Website Initiative

It is often said that "NOAA is where science gains value for the Nation." Over the last two years, NCDC has championed the development and coordination of a Socioeconomic Website Initiative for NOAA (www.ncdc.noaa.gov/oa/esb), a central source of information on the economic value and use of NOAA's data and products in both industry and society. Anticipated users of this website include the media, Congressional staffers, NOAA Program Managers, and the general public.

This initiative was originally developed for NOAA's Climate Goal, but expanded after a number of briefings and positive feedback from across the agency and some funding from NOAA's Chief of Staff. It can accommodate NOAA's other Mission Goals (i.e., Weather and Water, Ecosystems, and Commerce and Transportation) and is being implemented with NOAA's Office of Program Planning and Integration (PPI), NOAA's Social Science Committee (SSC), and with NOAA Goal representatives, in vetting and collecting new information for website content. This is possible through a partnership with StormCenter Communications, Inc.

NCDC's team is currently developing an Operations and Maintenance Plan, working with the office of NOAA's Chief Information Officer to acquire the www.economics.noaa.gov URL, and actively monitoring website visitation using commercial analytic tools. After a final round of vetting website content (by Program Planning and Integration (PPI), the Scientific Support Coordinator (SSC), and the NOAA Goal representatives), the website will become operational (e.g., NOAA users will be encouraged to edit/provide new content) and will be hyperlinked from NOAA's homepage.

The socioeconomic information contained within this website is synthesized from over 164 sources of peer-reviewed literature and is organized under each Mission Goal by data users (e.g., business sectors, the general public, federal agencies); extreme events (e.g., hurricanes, drought, space weather, coral bleaching); and NOAA observing systems (e.g., land surface, marine surface, satellite, upper air). As of January 2008, this website incorporates:

- 207 (98 unique) topic overview narratives, which provide a socioeconomic perspective on the value of NOAA data and products to society, as used in business, personal, policy decision making, etc.

- 164 sources of peer-reviewed literature, 117 of which are hyperlinked directly to the literature

- 115 summaries on the economic benefits of cost mitigation by NOAA data and products

- 155 summaries on the economic costs/impacts of environmental extreme events

- 763 data user stories (i.e., real-world accounts on the use of NOAA data/products in decision making)

- hundreds of external hyperlinks to NOAA data sets/products and internal hyperlinks interconnecting many NOAA program missions and responsibilities.

Datzilla Interactive Error Reporting, Tracking, and Resolution System

As a result of an effort by NCDC, via participation in a series of NWS data workshops, the importance and use of Datzilla has increased significantly. Datzilla, a web-based system allows authorized users to report suspected errors in NCDC and RCC data and services. Datzilla facilitates the efficient tracking of the disposition of those reports. Since its inception in March 2005, 775 Datzilla reports have been filed. Nearly half of those reports were filed in FY2007. To date, 548 reports have been resolved and/or closed. NCDC resolved and closed over half of these reports in FY2007 by providing an operational guidance document for NCDC handling of Datzilla reports and by adding an additional contract employee to work full-time on the investigation and resolution of Datzilla reports. As a direct result of the efforts of Datzilla reporters and investigators, the overall quality of the Nation's climate record has significantly improved.

Table of Datzilla Metrics

Datzilla Metric	Reports to date	Reports FY2007
NEW reports filed	775	377
NEW reports concerning NCDC	499	226
Reports RESOLVED*	548	277
Reports RESOLVED* by NCDC	378	214
Reports CLOSED**	340	163
Reports CLOSED** by NCDC	255	122
Reports OPEN† at start of FY2007	127	
Reports OPEN† at start of FY2007 concerning NCDC	109	
Reports OPEN† at end of FY2007	228	
Reports OPEN† at end of FY2007 concerning NCDC	121	

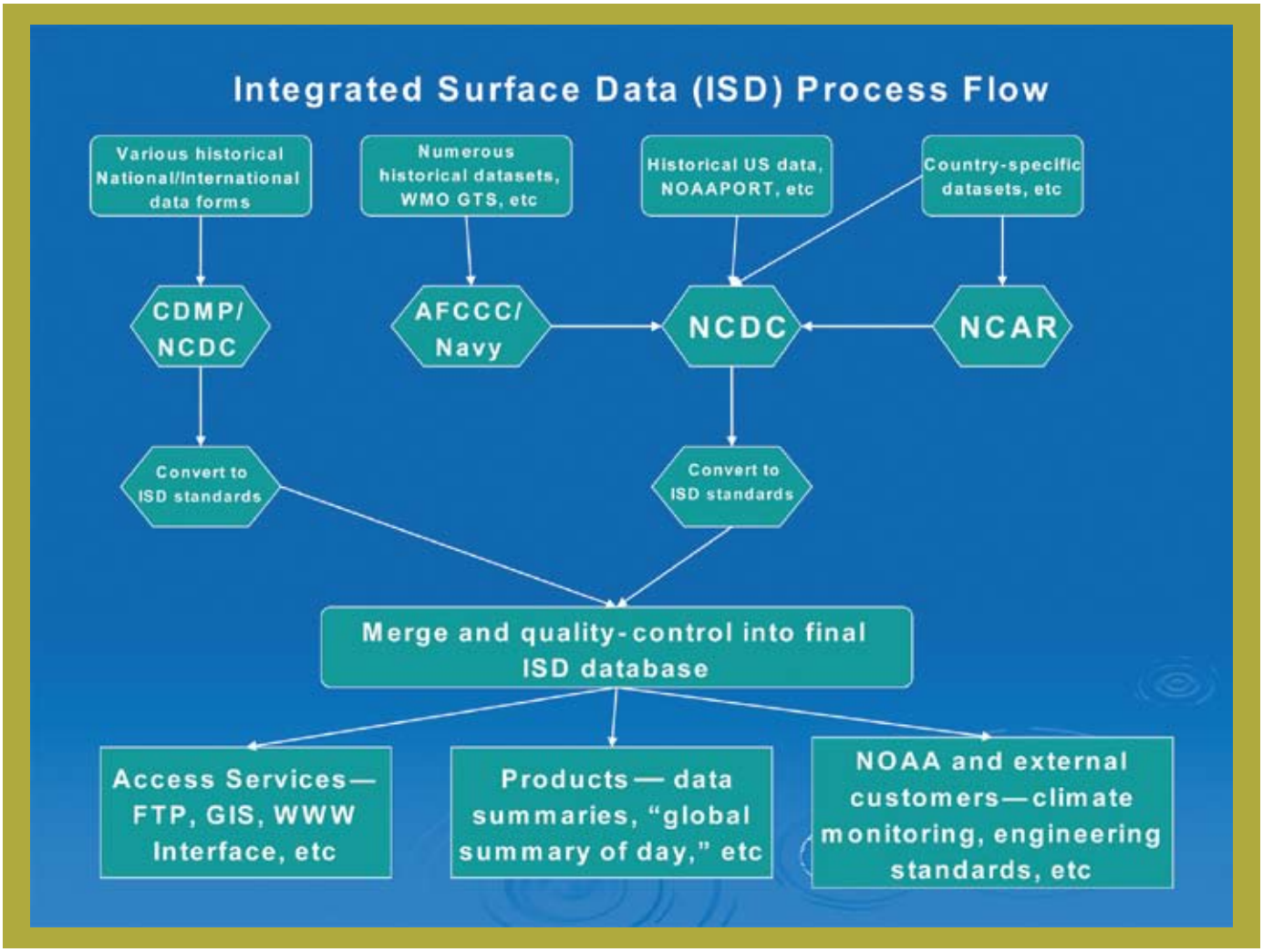
* RESOLVED indicates a report for which a resolution has been proposed
** CLOSED indicates a report on which the proposed resolution has been enacted
† OPEN includes only unresolved, unclosed reports

Integrated Station Information System (ISIS)

ISIS is a metadata tracking application with a flexible architecture designed for use with multiple climate observing networks. The application was put into production in February 2007, replacing the CRN sites metadata database. ISIS provides new features, including finely-tuned authentication, field constraints (without changing the database architecture), correction tracking, and the ability to save entered data for later completion. The application is designed to be used in the field with minimal training by utilizing the supplied User Guide.

Development on ISIS hit several milestones during FY2007. A quality control workflow mechanism was introduced to ISIS in June 2007. Each network can define quality control (QC) processes, and ISIS events can be moved through a series of reviews. Additionally, this modular component has the potential to be used for non-ISIS items, which require review. NCDC began ingesting data from ISIS into the Multi-Network Metadata System (MMS) in September 2007. This auto ingest process allows the operational system (ISIS) to send data to the metadata archive (MMS) eliminating the previous labor-intensive manual ingest process.

While CRN is currently the only climate observing network whose metadata is currently stored in ISIS, support for additional networks is planned for the next fiscal year. ISIS is designed to be scalable, and it is anticipated that many networks will find it a useful solution to metadata management.



Surface Data Processing and Integration

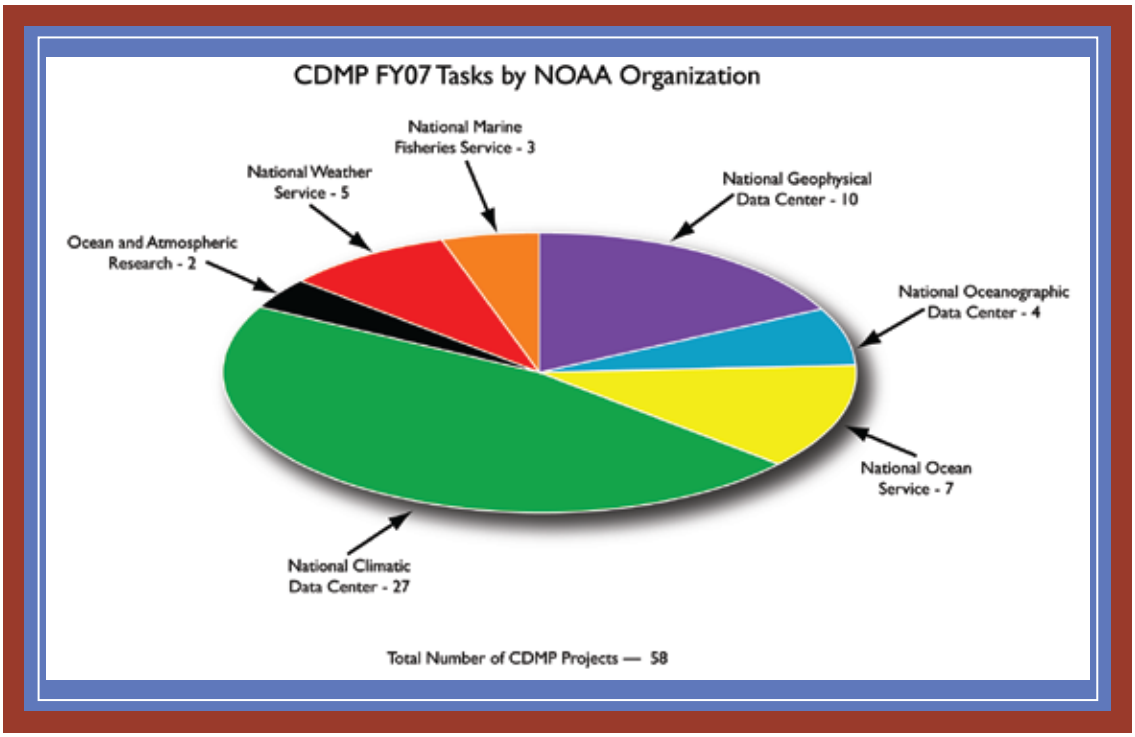
NCDC is responsible for the stewardship of global climatological data to support the GEOSS. In the past, these data were processed through quality assurance/control (QA/QC) systems that were primarily network-specific with no standard for rules/algorithms applied to similar parameters across the different observing networks. Therefore, NCDC implemented a plan to integrate surface climatological data into a common format and data model and process these data through one processing system that capitalizes on network independent standardized QA/QC algorithms and procedures.

NCDC developed an ISD format and database and a new QA/QC processing system, the Integrated Surface Data Processing System (ISDPS). ISD and ISDPS integrate QA/QC algorithms into a unified system. Numerous historical data sets have been fully integrated into ISD. Data from several sources and networks, totaling nearly 20,000 active observing sites, are now operationally processed (e.g., daily) through ISDPS. These sources include NOAA's Automated Surface Observing System (ASOS), the Automated Weather Observing System (AWOS), global hourly and synoptic data from the Air Force Combat Climatology Center (AFCCC), U.S. Navy station data, the National Cooperative Observers (COOP) Network, and the CRN.

Additional historical data sets are being integrated into ISD, and additional data sources and networks will gradually be integrated into ISDPS. NCDC is working with partners (NWS, RCC, State Climatologists, NCAR, AFCCC, etc.) to continue developing network-independent standards for QA/QC and to further expand ISD.

NCDC's most popular online data set, ISD, continues to be expanded with additional data sources. For example, data key-entered from forms dating to the late 1800s to 1900s are being integrated into ISD, due to the efforts of the Climate Database Modernization Program (CDMP). A partnership with the NCAR is resulting in many national and regional data sets being integrated. Also, USCRN data are now included in the ISD processing system. These are just a few examples of long-term efforts, so users will continue to see a gradual temporal

and spatial expansion of data availability. Over 1.7 billion surface observations are now included in this data set. The URL: www.ncdc.noaa.gov/oa/climate/isd/index.php.



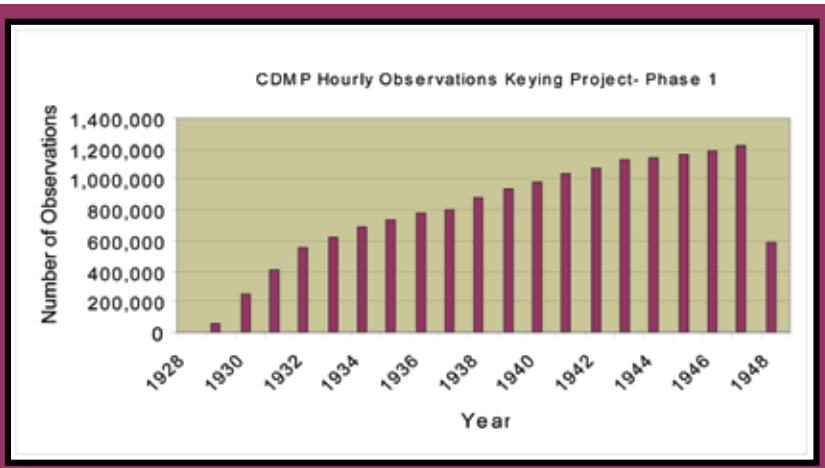
Climate Database Modernization Program (CDMP)

NOAA's CDMP has just completed its eighth year. Climate science has made major advances during the last two decades, yet the integration of climate information into business and economic sector planning and decision making process is in its infancy.

The CDMP has and will continue to transform NOAA's paper and microform archives into an electronic database. Access to this database by business and economic sectors will allow these decision makers to take climate information into account when making decisions. This demand for rapid and complete access to the Nation's and world's climate data is a key driver in the establishment of CDMP, which is managed through NCDC. This program was initiated by Congress to assist NOAA in modernizing and improving access to the Nation's climate data and information. Partnering with four private sector contractors, CDMP has placed online over 52 million weather and environmental images. These historic documents are now available to researchers and decision makers in both the public and private sector via the Internet.

Major advances in data rescue and digitization continue in making these data available on the web through a number of NOAA web sites. During the next year or so, CDMP will start to make available keyed hourly data for several early climate locations that recorded hourly temperature data during the 19th century. These data will extend the period of record for selected locations back into the early to mid 1800s and be useful for climate change and variability studies.

The increase in data accessibility and further integrated global databases needed by today's climate and environmental data users validate the CDMP mission: to make major climate and environmental databases available via the World Wide Web.



Number of historical hourly observations (Pre-1948) integrated into NCDC Climate Data Online (CDO) system. Several million additional observations extending back to 1893 will also be added to the CDO.

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Note: NOAA NCDC Personnel indicated with an "" either retired, resigned, or transferred during the 2007 calendar year.*

List of Acronyms

AASC
American Association of State Climatologists, Inc.

ACIS
Applied Climate Information System

AFCCC
Air Force Combat Climatology Center

AMOC
Atlantic Meridional Overturning Circulation

AMS
American Meteorological Society

ASOS
Automated Surface Observation System

AWOS
Automated Weather Observing System

CASA
Collaborative Adaptive Sensing of the Atmosphere

CCSP
Climate Change Science Program

CDMP
Climate Database Modernization Program

CDO
Climate Data On-line

CDR
Climate Data Record

CFSRR
Climate Forecast System Reanalysis and Reforecast

CIMMS
Cooperative Institute for Mesoscale Meteorological Studies

CIR
Climate Information Record

COOP
National Cooperative Observer Network

FTP
File Transfer Protocol

FY
Fiscal Year

GCOS
Global Climate Observing System

GEO
Group on Earth Observations

GEO-IDE
Global Earth Observation-Integrated Data Environment

GEOSS
Global Earth Observation System of Systems

GHCN
Global Historical Climate Network

GIS
Geographical Information System

GOSIC
Global Observing Systems Information Center

GUI
Graphical User Interface

HIRS
High-resolution Infrared Radiation Sounder

IDE
Integrated Data Environment

IDEA
Integrated Data and Environmental Applications (Center)

IMPD
International Multiproxy Paleofire Database

IPCC
Intergovernmental Panel on Climate Change

ISD
Integrated Surface Data

ISDPS
Integrated Surface Data Processing System

ISH
Integrated Surface Hourly

ISIS
Integrated Station Information System

MMS
Multi-Network Metadata System

MOU
Memorandum of Understanding

NASA
National Aeronautics and Space Administration

NCAR
National Center for Atmospheric Research

NCDC
National Climatic Data Center

NCEP
National Centers for Environmental Prediction

NEMAC
National Environmental Modeling and Analysis Center

NEXRAD
Next Generation Weather Radar

NIDIS
National Integrated Drought Information System

NMFS
National Marine Fisheries Service

NMQ
National Mosaic and Multi-sensor Quantitative (Project)

NOAA
National Oceanic and Atmospheric Administration

NOMADS
National Operational Model Archive and Distribution System

NPOESS
National Polar-Orbiting Operational Environmental Satellite System

NREL
National Renewable Energy Laboratory

NSRDB
National Solar Radiation Database

NSSL
National Severe Storms Laboratory

NVDS
NOAA Virtual Data System

NWS
National Weather Service

OGC
Open Geospatial Consortium

OpenDAP
Open-source Project for a Network Data Access Protocol

OSTP
Office of Science and Technology Policy

PPI
Program Planning and Integration

PRICIP
Pacific Region Integrated Climatology Information Products

PRIDE
Pacific Region Integrated Data Enterprise

QA
Quality Assurance

QC
Quality Control

QPE
Quantitative Precipitation Estimation

RCC
Regional Climate Center

RENCI
Renaissance Computing Institute

REST
Representational State Transfer

SOA
Service Oriented Architecture

SOAP
Simple Object Access Protocol

SRAP
Storm Risk Assessment Project

SSC
Scientific Support Coordinator

SWDI
Severe Weather Data Inventory

THORPEX
The Observing System Research and Predictability Experiment

TIGGE
The Interactive Grand Global Ensemble

UNC
University of North Carolina

USCRN
U.S. Climate Reference Network

USDA
U.S. Department of Agriculture

USFS
U.S. Forest Service

USGS
U.S. Geological Survey

UTWV
Upper Tropospheric Water Vapor

WDC
World Data Center

WMO
World Meteorological Organization

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